Recommendations for Water Quality Standards Revisions

Reclassification of Beneficial Uses for Cascade Creek, Fall River County

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South Dakota Department of Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

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Executive Summary

Cascade Creek was monitored during a Total Maximum Daily Load (TMDL) assessment project for the Upper Cheyenne River from September 2003 through September 2005. Water temperature measurements collected during this TMDL assessment project exceeded the criterion in place to protect the beneficial use of coldwater permanent fish life propagation. All other water quality parameters tested during this TMDL assessment met the water quality criteria for the coldwater permanent fish life propagation use.

The USGS maintained a discharge gaging station (06400497) on Cascade Creek at Cascade Springs from 1977 to 1997, where various field measurements (including water temperature) were measured on a semi-monthly basis. USGS temperature measurements violated criterion 154 times out of 157 samples (98% exceedance).

Although low in abundance, coldwater fish species (brown and rainbow trout) were sampled during two fish surveys conducted by the South Dakota Department of Game Fish and Parks (SD GFP). Based on these fish survey data and fish stocking records (SD GFP, unpublished data), reclassifying the fishery beneficial use from a coldwater permanent fishery to a coldwater marginal fishery is recommended. A reclassification to a coldwater marginal fishery would be in line with management of the fishery by the SD GFP as a "put and take" fishery.

SD DENR defines the beneficial use of coldwater marginal fish life propagation as "a beneficial use assigned to waters which support aquatic life and are suitable for stocked catchable-size coldwater fish during portions of the year, but due to critical natural conditions including low flows, siltation, or warm temperatures, are not suitable for a permanent coldwater fish population. Warmwater fish may also be present." (SD DENR, 1999). The daily maximum water temperature criterion for a coldwater marginal fishery is 75°F. This temperature criterion would be met in Cascade Creek, allowing for natural conditions and protecting the biological integrity and fishery use of the stream.

Watershed and Monitoring Site Information

Cascade Creek drains approximately 66.4 km^2 (25.6 mi^2) before emptying to the Cheyenne River just upstream of the Highway 71 bridge in Fall River County. Cascade Springs is approximately 2.5 miles upstream from the creek's confluence with the Cheyenne River, and contributes the majority of stream flow to Cascade Creek. Cascade Springs is a group of artesian springs originating from the contact along the Spearfish formation and the underlying Minnekahta limestone and is believed to be fed by the Madison and Minnelusa aquifers (Hayes, 1999).

The Cascade Creek monitoring site (CA-1) was located approximately 0.3 miles upstream from the stream's confluence with the Cheyenne River (Figure 1). The USGS maintained a continuous discharge gaging station (06400497) on Cascade Creek at Cascade Springs from 1977 to 1997 and measured stream temperature semi-monthly during the same time period.

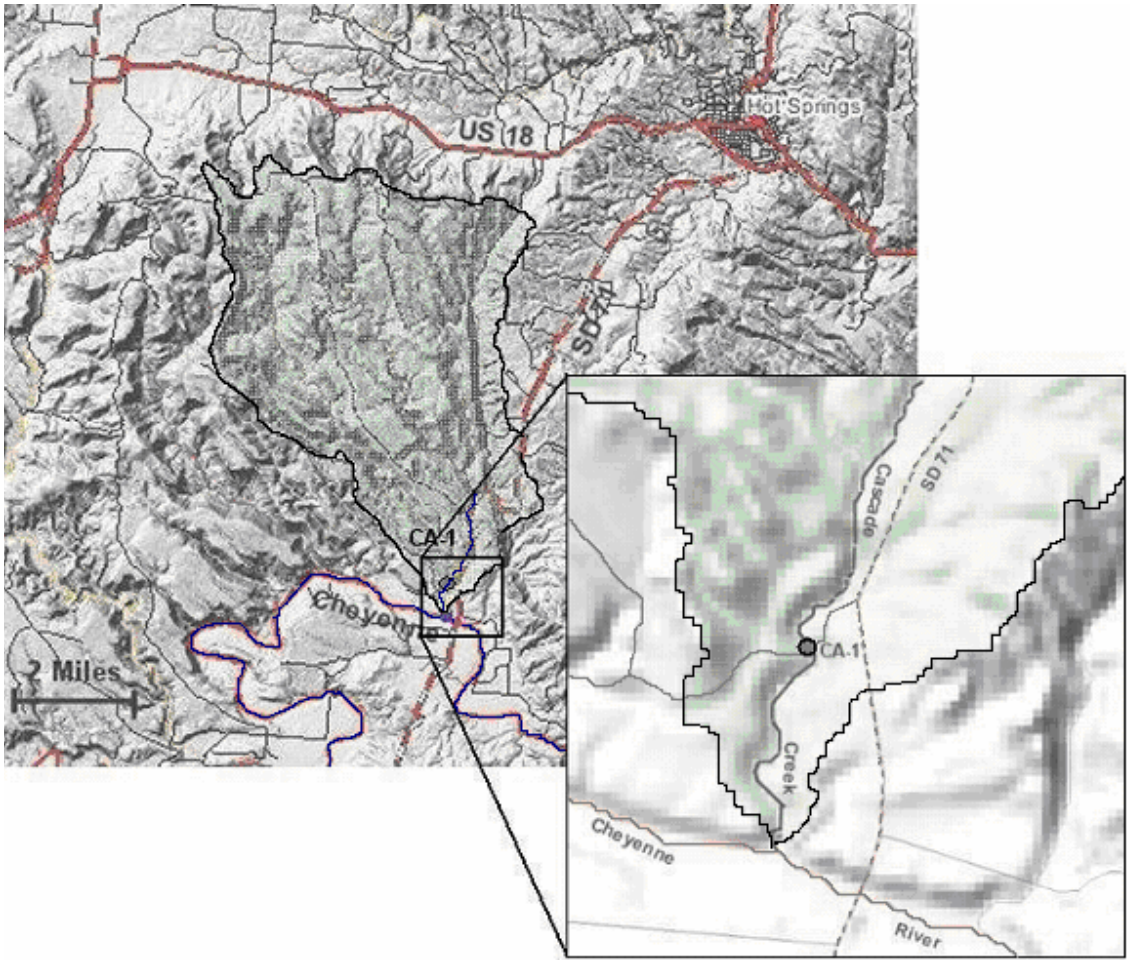

Figure 1. Cascade Creek watershed and sampling site.

Beneficial Uses and Water Quality Criteria

Chapter 74:51:03 of the Administrative Rules of South Dakota (ARSD) assigns the following beneficial uses to Cascade Creek:

- Coldwater permanent fish life propagation
- Immersion recreation
- Limited contact recreation
- Fish and wildlife propagation, recreation and stock watering
- Irrigation

Water quality criteria to protect these beneficial uses are contained in ARSD 74:51:01, and of these only the water temperature criterion is not being met. The daily maximum water temperature criterion for coldwater permanent fish life propagation waters is 75°F (ARSD §74:51:01:46). Coldwater permanent fish life propagation is defined as "a beneficial use assigned to streams which are capable of supporting aquatic life and are suitable for a permanent population of coldwater fish from natural reproduction and to lakes capable of supporting a permanent population of coldwater fish from natural reproduction or fingerling stocking. Warmwater fish may also be present." (SD DENR, 1999).

Assessment Results

STREAM FLOW

The USGS maintained a discharge gaging station (06400497) on Cascade Creek at Cascade Springs from 1977 to 1997. Flow from Cascade Springs is quite consistent. Average annual flow ranges from 16.3 to 21.3 cfs with very little season variation (Figure 2). Monthly average flow for the period of record ranges from 19 to 20 cfs. Slightly higher monthly average flows occur from May through August (20 cfs) than during the rest of the year (19 cfs).

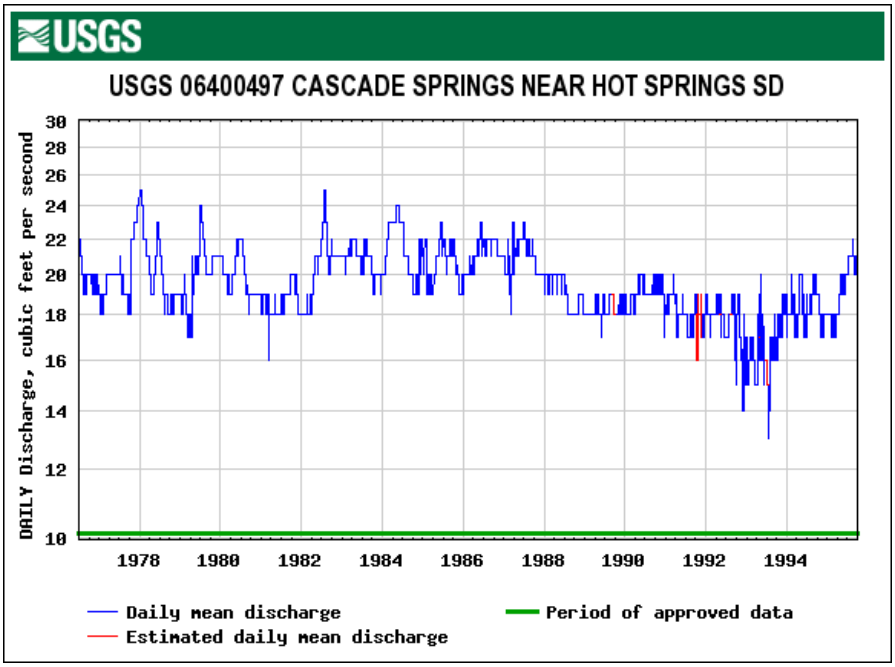

Figure 2. United States Geological Survey (USGS) daily mean discharge measurements (blue) and estimates (red) for Cascade Springs near Hot Springs, SD (USGS site 06400497) from July 1, 1976 to September 30, 1995. Retrieved from http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=06400497

WATER QUALITY

Descriptive statistics for Cascade Creek samples collected at CA-1 are shown in Table 2**Error! Not a valid link.**. The table lists each parameter sampled, the number of samples taken (n), and the mean, median, standard deviation, minimum value, and maximum value of sample results for each parameter. Temperature data collected by the USGS at gage 06400479 (Cascade Creek at Cascade Springs) are included. Due to its water source, Cascade Creek water chemistry displayed little variability during the TMDL study period. Also likely due to the source of the water, high concentrations of calcium and sulfate, compared to other streams in the area, were observed in Cascade Creek.

Table 1. Descriptive statistics for samples and field measurements at Cascade Creek Site CA-1, showing number of samples (n), sample mean, median, standard deviation, and minimum and maximum values.

Parameter	n	Mean	Median	Standard Deviation	Min	Max
Discharge (cfs)	25	20.2	21.5	4.81	12.3	26.6
Water Temp (ºF)	25	62.9	62.7	5.00	55.3	72.1
Water Temp (ºF) (USGS)	157	68.4	68	1.36	64.4	72.5
Specific Conductivity (µS/cm)	23	2479	2537	138	2179	2627
pH	25	7.94	8.00	0.240	7.06	8.28
D.O. (mg/L)	25	9.35	9.26	0.888	8.21	11.7
Turbidity (NTU)	24	0.25	0.15	0.666	-1.10	2.10
$NO_2 + NO_3$ (mg/L)	25	0.447	0.330	0.667	0.050	3.63
Dissolved Ammonia (mg/L)	25	0.038	0.050	0.023	0.005	0.101
Dissolved P (mg/L)	25	0.017	0.005	0.019	0.005	0.090
Total P (mg/L)	25	0.025	0.005	0.043	0.005	0.209
Total Kjeldahl Nitrogen (mg/L)	25	0.175	0.120	0.109	0.015	0.456
SO_4 (mg/L)	25	1436	1453	72.3	1243	1531
Cl (mg/L)	24	51.0	46.9	26.1	29.7	169
Ca (mg/L)	25	524	525	24.0	488	589
Mg (mg/L)	25	80.6	81.8	3.81	72.2	88.3
Na (mg/L)	25	38.3	35.0	6.91	32.0	59.4
K (mg/L)	25	5.35	5.30	1.37	0.500	7.4
Hardness as $CaCO_3$ (mg/l)	23	1641	1646	70.8	1534	1834
Alk as $CaCO_3$ (mg/L)	24	166	173	35.2	2.50	184
SAR	25	0.41	0.38	0.075	0.343	0.632
Total Organic Carbon (mg/L)	24	1.06	0.500	2.05	0.500	10.6
Total Dissolved Solids (mg/L)	23	2231	2240	111	2027	2394
Total Suspended Solids (mg/L)	25	4.51	4.02	2.34	2.00	11.8
Volatile Solids (mg/L)	25	2.03	1.60	1.63	0.25	6.00
Total Solids (mg/L)	25	2489	2488	118	2140	2732
Fecal Coliform (CFU/100mL)	22	7.55	5.00	6.81	1.00	30.0

FISH SURVEYS

The South Dakota Department of Game, Fish and Parks (SD GFP) conducted fish community surveys on May 11, 1993 and August 26, 1998 at one site on Cascade Creek. Fish were collected from a 100-meter stream reach and measured for length and weight.

On May 11, 1993, two fish species were collected: brown trout (*Salmo trutta*) and long-nosed dace (*Rhinichthys cataractae*). Brown trout was the most abundant species (Table 2), with lengths ranging from 172 – 282 mm (Figure 3).

Table 2. Total number and size and weight range of fish species collected by SD GFP from Cascade Creek on May 11, 1993 (SD GFP, unpublished data).

Fish Species	Common Name	Total Number	Size Range (mm)	Weight Range (grams)
Salmo trutta	Brown Trout	13	172-282	48-240
Rhinichthys cataractae	Long-nosed Dace	2	43-44	1

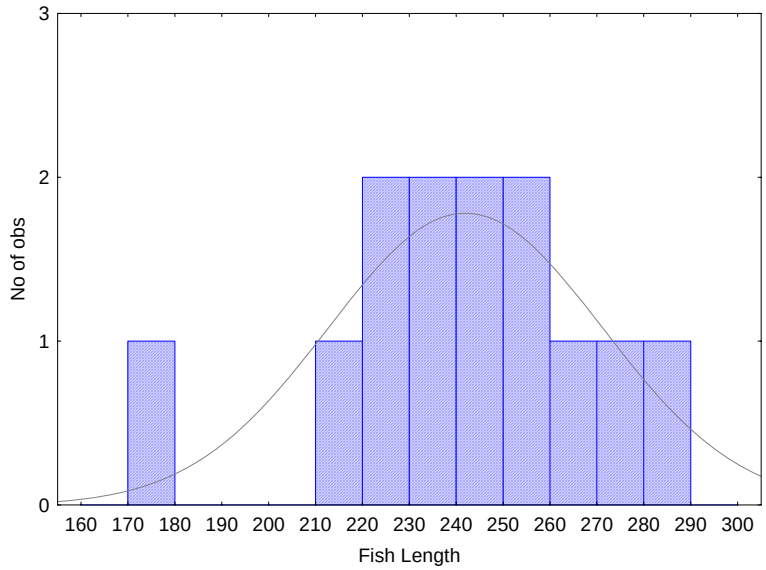

Figure 3. Frequency histogram of brown trout (*Salmo trutta*) size classes observed in Cascade Creek fish survey conducted on May 11, 1993 (SD GFP, unpublished data).

On August 26, 1998, three fish species were collected: long-nosed dace (*Rhinichthys cataractae*), white sucker (*Catostomus commersoni*) and rainbow trout (*Oncorhynchus mykiss*). Long-nosed dace was the most abundant species (

Table 3), with lengths ranging from 54 – 87 mm (Figure 4). GFP has not conducted any recent stream surveys on Cascade Creek, but considers the 1990s surveys to be representative of existing conditions.

Cascade Creek is managed by the SD GFP as a 'put and take' cold-water fishery. Cascade Creek is currently only stocked in the late winter or early spring, during the time that trout can survive. There is no evidence if natural reproduction and trout survival past summer is poor. The stream was originally stocked in 1917 with cutthroat and rainbow trout fingerlings. Since then, the stream has been periodically stocked with mostly catchable-sized brown and rainbow trout. From 1981 to 2000, the stream was stocked annually with catchable-sized rainbow and brown trout. Since 2004, the stream has been stocked with catchable-sized rainbow trout only.

Table 3. Total number and size and weight range of fish species collected by SD GFP from Cascade Creek on August 26, 1998 (SD GFP, unpublished data).

Fish Species	Common Name	Total Number	Size Range (mm)	Total Weight (grams)
Rhinichthys cataractae	Long-nosed Dace	61	54-87	1-6
Catostomus commersoni	White Sucker	9	156-240	40-138
Oncorhynchus mykiss	Rainbow Trout	1	283	256

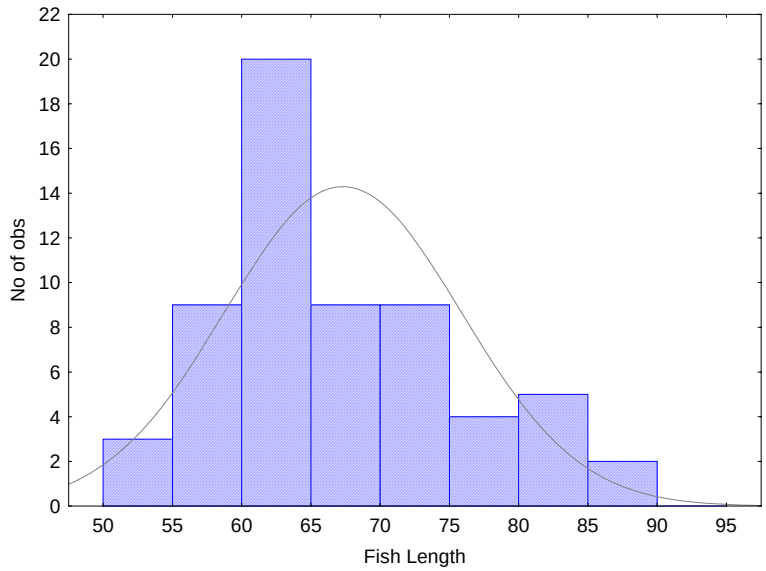

Figure 4. Frequency histogram of long-nosed dace (*Rhinichthys cataractae*) size classes observed in Cascade Creek fish survey conducted on August 26, 1998 (SD GFP, unpublished data).

STREAM TEMPERATURE MONITORING

Temperature data from both the USGS and TMDL study indicate that the temperature criterion for coldwater permanent fish life propagation is regularly exceeded. Of 25 monthly measurements collected during the TMDL study, 36% violated the daily maximum temperature criterion of 65°F for the beneficial use of cold water fish life propagation. Figure 5 is a graph of temperature data collected during the study; the dashed line is the 65°F criterion. The graph shows that criterion exceedances occur during spring and summer months. All measurements were recorded approximately between 9:00 am and 3:00 pm. Diurnal temperature variation likely causes temperature fluctuations in the downstream portion of Cascade Creek that exceed standards daily during summer months, although continuous monitoring would have to be implemented to verify this assumption.

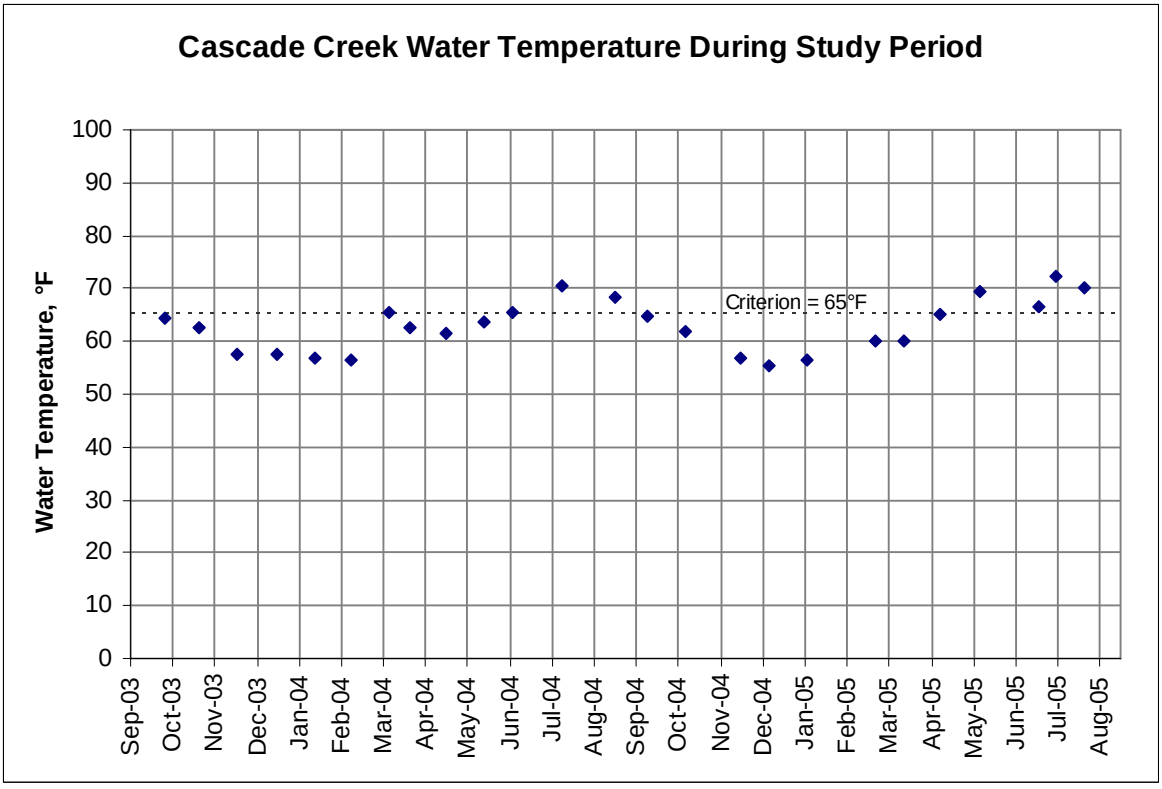

Figure 5. Water temperature of monthly Cascade Creek samples with criterion.

The USGS maintained a discharge gaging station (UGSG gage 06400497) on Cascade Creek at Cascade Springs from 1977 to 1997. Monthly temperature data collected by the USGS during this period is shown in Figure 6. The chart displays stream discharge and temperature data collected at the USGS site, temperature data from the TMDL study, and a dashed line showing State criterion. During this period, Cascade Creek temperatures consistently violated State water quality standards meant to protect the beneficial use of cold water fish life propagation. USGS temperature measurements violated criterion 154

times out of 157 samples (98% exceedance). Measurements had a mean temperature of 68.4°F, a median of 68°F, and a standard deviation of 1.36°F. The highest, non-outlier temperature measurement was 72.5°F on May 6, 1987; the maximum temperature measured during the TMDL study was 72.1°F on July 13, 2005. A temperature of 80.6ºF was recorded by USGS at Cascade Springs on 7/24/1979. The fact that the next highest value recorded was 72.5ºF and the standard deviation of 157 values was 1.36 leads the authors to conclude that this measurement was very likely an error and, for this reason, has not been used in temperature analysis

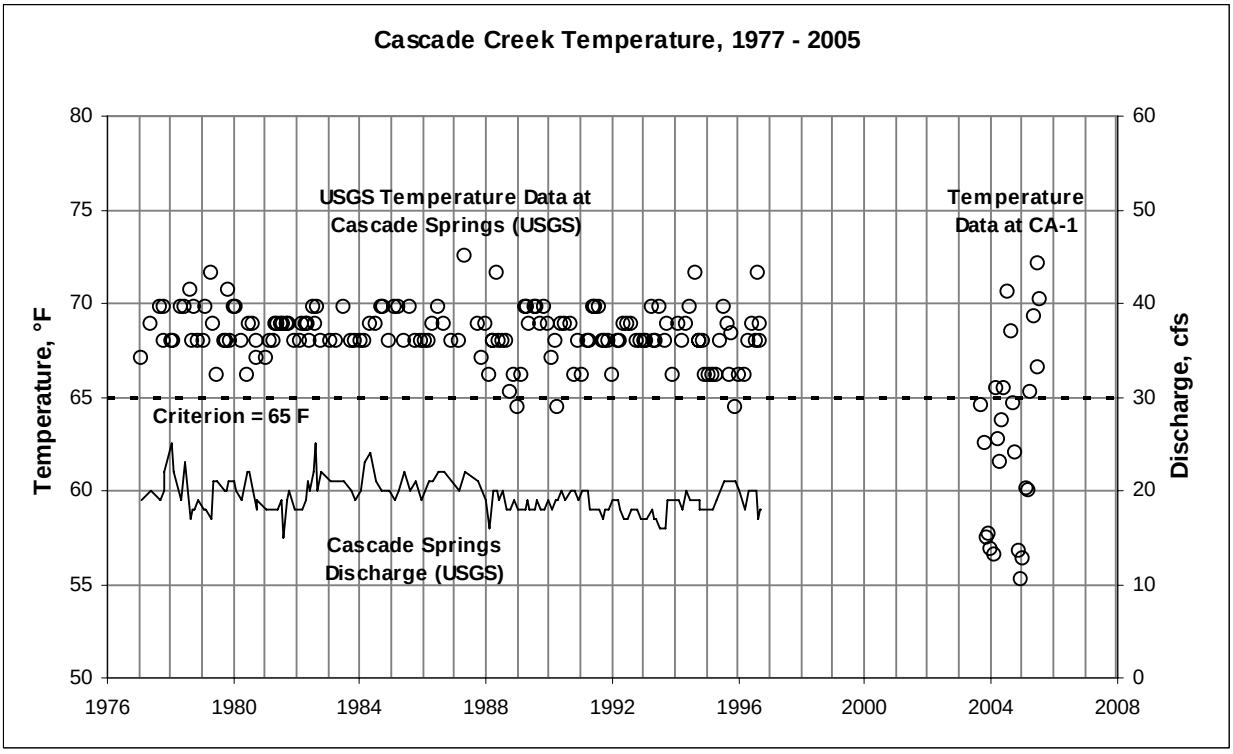

Figure 6. Temperature of Cascade Creek at two sites: USGS discharge gaging station 06400497 (Cascade Springs near Hot Springs, SD) and CA-1. Also shown is stream flow data collected at the USGS site and the current State temperature criterion for Cascade Creek.

Downstream temperatures collected during this study at site CA-1 show greater variation than those measured at the source by USGS. This is likely due to cooling or heating of stream water exposed to ambient air temperatures as the stream flows two miles from Cascade Springs to the CA-1 monitoring site.

Summary and Recommendations

High stream temperatures measured by USGS and those measured in this study are naturally occurring. The stream source is a small group of artesian springs, and waters issuing forth are already warmer than the maximum allowable temperature criterion

meant to protect the beneficial use of cold water fish life propagation. Stream temperatures in Cascade Creek cannot be controlled or reduced.

Based on fish survey data and fish stocking records (SD GFP, unpublished data), reclassifying the fishery beneficial use from a coldwater permanent fishery to a coldwater marginal fishery is recommended. SD DENR defines the beneficial use of coldwater marginal fish life propagation as "a beneficial use assigned to waters which support aquatic life and are suitable for stocked catchable-size coldwater fish during portions of the year, but due to critical natural conditions including low flows, siltation, or warm temperatures, are not suitable for a permanent coldwater fish population. Warmwater fish may also be present." (SD DENR, 1999). A reclassification to a coldwater marginal fishery would be in line with management of the fishery by the SD GFP as a "put and take" fishery.

The daily maximum water temperature criterion for a coldwater marginal fishery is 75°F. Cascade Creek would meet this water temperature limit. This temperature criterion would allow for natural conditions and protect the biological integrity and fishery use of the stream.

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